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A Device for Rapid Conversion of Titration Values to Salinity

The conversion of titration units to salinity units using the Knudsen table[1] is slow and tedious when many data are being processed. I have made a study of the salinity equation which resulted in various graphical solutions. The graph shown in Figure 1 is probably the simplest of those derived, requiring only slight modification to convert it into a device that can be used to convert titration units into salinity units with a precision and speed far exceeding that obtained by using the Knudsen conversion tables.

THE SALINITY EQUATION

The salinity equation states that if the sample volume and reagent concentration remain constant, the following relationship exists: $\frac{Sp}{a} = k$, where S and p are the salinity and density, respectively, of the sample, a the volume of silver nitrate reagent necessary to titrate the sample, and k a constant. Since the equation contains two unknowns, S and p, it is solved by estimating values for S and p and then correcting the estimations with the aid of Knudsen's tables. The following example will illustrate this:

Let S = unknown salinity = $\frac{ak}{p}$

a = 17.000 double ml at an alpha[2] value of 0.000

k will be 1.85727 at the above alpha level

The p of the sample is estimated to be 1.00000. This estimation is purposely low. The use of a minimum estimate of 1.00000 will show that the maximum number of corrections necessary is four.

The first estimated S will therefore be $\frac{17 \times 1.85727}{1.00000}$ or 31.574‰.

The actual density corresponding to a salinity of 31.574 is 1.02537 (Knudsen tables). The second estimate will therefore be $\frac{17.000 \times 1.85727}{1.02537}$ or 30.792‰. Similarly, the third and fourth estimates will be 30.812 and 30.811‰ The fourth estimate is obviously the solution of the equation since the p value used in calculating S = 30.811 is the same as the Knudsen table value.

Usually two and never more than four estimates will result in an S value correct to the nearest .001‰. This procedure was used to calculate the values listed in Table 1.

A GRAPHICAL SOLUTION OF THE SALINITY EQUATION

A graphical presentation of the equation just described is shown in Figure 1. The horizontal axis makes up the salinity scale which is calibrated in parts per thousand (‰). The unit values are equally spaced. The vertical axis is calibrated in alpha units. The values on this axis, which are expressions of reagent concentration, cover a range from −.10 to +.10 and are equally spaced as shown. Should the silver nitrate reagent concentration fluctuate to an extent that would make this range impractical, it may be extended as desired. The titration scale is represented by the diagonal lines. The units on this scale are double milliliters. The scale is calibrated by calculating the salinity values that correspond to a titration reading at alpha levels of +.10 and −.10. The points representing the two values are connected with a straight line. Similarly, the pairs of values calculated for other readings are calculated and connected. Table 1 lists the titration readings and

[1] Knudsen, Martin. 1901. Hydrographical Tables. Copenhagen and London.

[2] The term "alpha" is used to designate the concentration of the silver nitrate solution used in the titration of a salinity sample. The alpha is numerically equal to the chlorinity of Copenhagen Standard sea water minus the number of double milliliters required to titrate 15 ml of it.

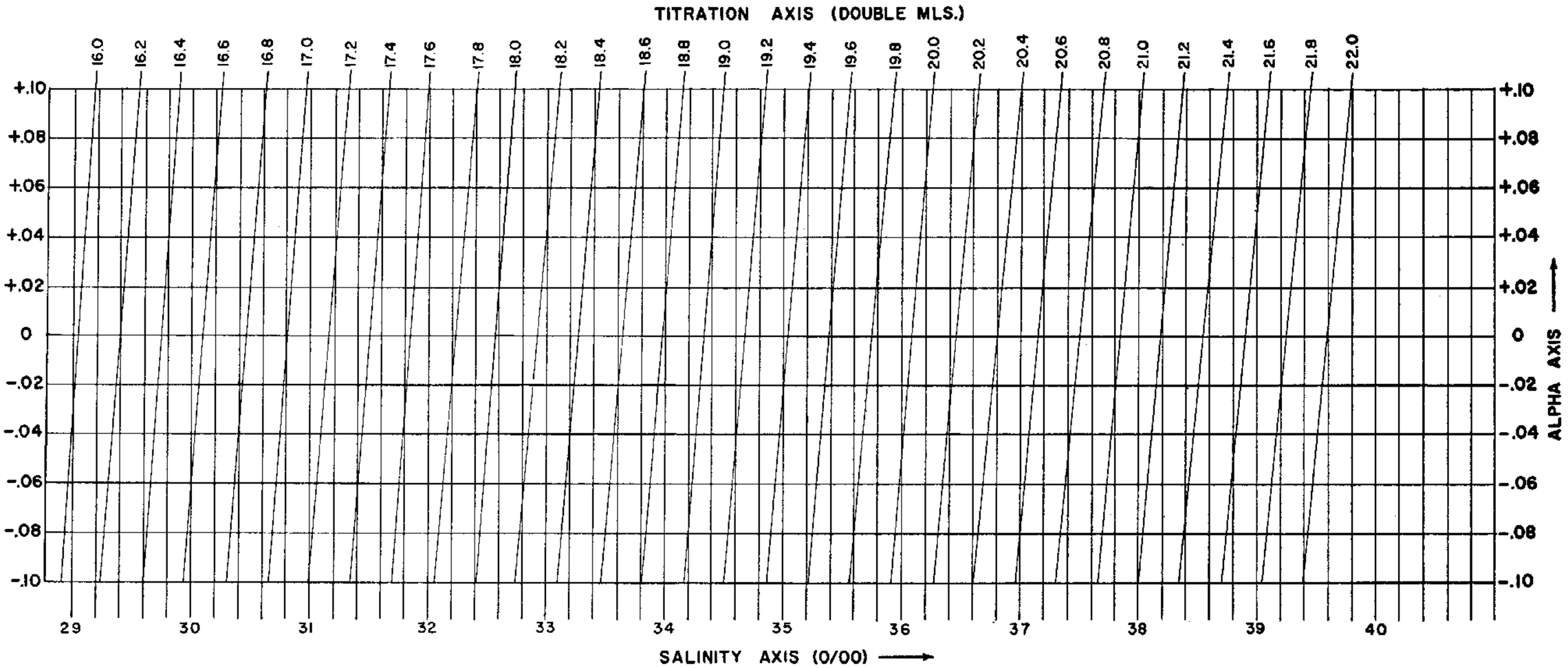

FIG. 1. Graphical solution of the salinity equation, $\frac{Sp}{a} = k$.

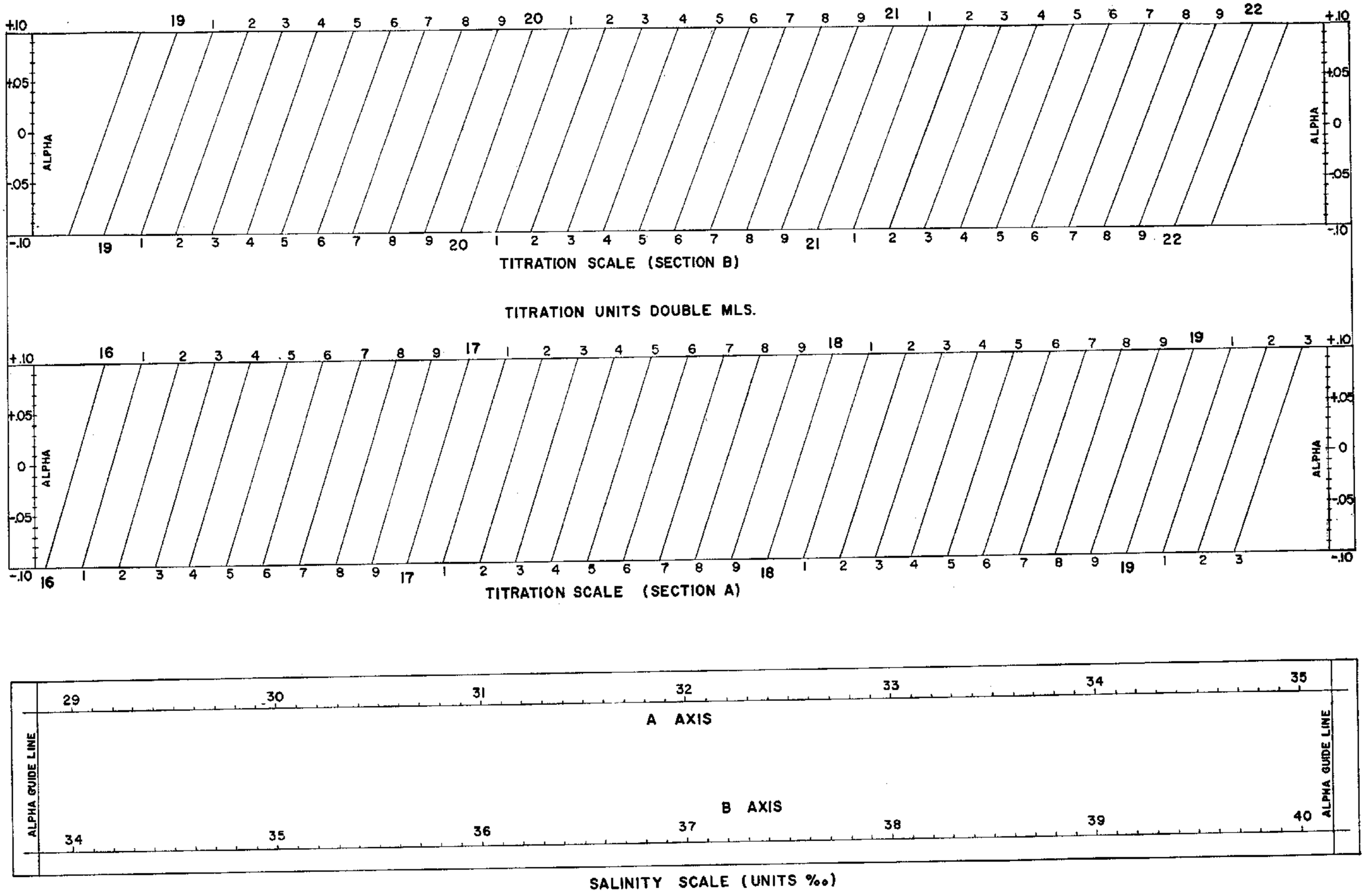

FIG. 2. Device for rapid and accurate conversion of titration values to salinity units.

TABLE 1. *Titration and salinity values used in constructing Figures 1 and 2.*

Titration (double ml)	Salinity at an alpha of +.10	Salinity at an alpha of −.10	Titration (double ml)	Salinity at an alpha of +.10	Salinity at an alpha of −.10	Titration (double ml)	Salinity at an alpha of +.10	Salinity at an alpha of −.10
16.0	29.186	28.893	18.0	32.743	32.415	20.0	36.280	35.918
.1	.364	29.069	.1	.920	.590	.1	36.456	36.092
.2	.543	.246	.2	33.098	.766	.2	.633	.267
.3	.721	.423	.3	.275	.942	.3	.809	.442
.4	.899	.599	.4	.452	33.117	.4	.985	.617
.5	30.077	.775	.5	.629	.293	.5	37.161	.791
.6	.255	.952	.6	.806	.468	.6	.338	.965
.7	.433	30.130	.7	.983	.643	.7	.514	37.139
.8	.611	.304	.8	34.160	.818	.8	.690	.314
.9	.789	.480	.9	.337	.994	.9	.865	.488
17.0	.967	.657	19.0	.514	34.169	21.0	38.042	.662
.1	31.145	.832	.1	.691	.344	.1	.217	.836
.2	.322	31.008	.2	.868	.519	.2	.394	38.011
.3	.500	.185	.3	35.044	.694	.3	.569	.185
.4	.677	.360	.4	.221	.869	.4	.745	.358
.5	.856	.536	.5	.398	35.044	.5	.921	.533
.6	32.033	.712	.6	.574	.219	.6	39.097	.707
.7	.211	.886	.7	.751	.394	.7	.272	.880
.8	.388	32.063	.8	.927	.568	.8	.448	39.054
.9	.565	.239	.9	36.104	.743	.9	.623	.228
						22.0	.798	.402

corresponding salinity values that were used in the construction of the graph shown in Figure 1.

The dimensions between units has not been given since these can be varied depending upon the precision desired. A salinity value having a precision of ±.002‰ can be obtained if the distance between the .10 and −.10 alpha levels is 10 inches and also that this same distance separates the unit values on the salinity scale. A graph of these dimensions should have the unit values on both the salinity and titration axes divided into 100 equal parts. The smallest division on each of these scales will thus represent .01 of a unit.

CONSTRUCTION OF THE DEVICE

The device is a modified version of the graph just described. The only change consists of engraving the salinity scale on a strip of Lucite. This permits the salinity axis to be placed directly over the titration readings at any desired alpha level, thus permitting a rapid and accurate conversion of titration to salinity units. Figure 2 shows the complete device. For compactness it is made in two sections. Section A contains titration readings from 16 to 19 double ml and section B, 19 to 22. The corresponding sections of the salinity scale are engraved one over the other as shown. The vertical lines engraved on either side of the salinity scale are alpha guide lines. Their purpose is to prevent horizontal wandering of the salinity axis which would result in erroneous results. The range of titration values given is the same as that on a Knudsen Burette. The device, as described, may therefore be used to convert to salinity units any titration reading made with a Knudsen Burette.

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